

Universal serial bus interfaces for data and power -  
Part 1-3: Common components - USB Type-C® Cable  
and Connector Specification

This document is a preview generated by EVS

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN IEC 62680-1-3:2021 sisaldab Euroopa standardi EN IEC 62680-1-3:2021 ingliskeelset teksti.	This Estonian standard EVS-EN IEC 62680-1-3:2021 consists of the English text of the European standard EN IEC 62680-1-3:2021.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 26.03.2021.	Date of Availability of the European standard is 26.03.2021.
Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 33.120.20, 33.120.30, 35.200

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardimis- ja Akrediteerimiskeskusele. Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardimis- ja Akrediteerimiskeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardimis- ja Akrediteerimiskeskusega: Koduleht [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation and Accreditation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation and Accreditation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation and Accreditation:

Homepage [www.evs.ee](http://www.evs.ee); phone +372 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

EUROPEAN STANDARD

**EN IEC 62680-1-3**

NORME EUROPÉENNE

EUROPÄISCHE NORM

March 2021

ICS 33.120.20; 33.120.30; 35.200

Supersedes EN IEC 62680-1-3:2018 and all of its amendments and corrigenda (if any)

English Version

**Universal serial bus interfaces for data and power - Part 1-3:  
Common components - USB Type-C(r) Cable and Connector  
Specification  
(IEC 62680-1-3:2021)**

Interfaces de bus universel en série pour les données et  
l'alimentation électrique - Partie 1-3: Composants communs  
- Spécification des câbles et connecteurs USB Type-C(r)  
(IEC 62680-1-3:2021)

Schnittstellen des Universellen Seriellen Busses für Daten  
und Energie - Teil 1-3: Gemeinsame Bauteile - Festlegung  
für USB-Typ-CTM-Kabel und -Steckverbinder  
(IEC 62680-1-3:2021)

This European Standard was approved by CENELEC on 2021-03-23. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

## European foreword

The text of document 100/3439/CDV, future edition 4 of IEC 62680-1-3, prepared by IEC/TC 100 "Audio, video and multimedia systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62680-1-3:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2021-12-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024-03-23

This document supersedes EN IEC 62680-1-3:2018 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

### Endorsement notice

The text of the International Standard IEC 62680-1-3:2021 was approved by CENELEC as a European Standard without any modification.

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Universal serial bus interfaces for data and power –  
Part 1-3: Common components – USB Type-C® Cable and Connector  
Specification**

**Interfaces de bus universel en série pour les données et l'alimentation  
électrique –  
Partie 1-3: Composants communs – Spécification des câbles et connecteurs  
USB Type-C®**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC online collection - [oc.iec.ch](http://oc.iec.ch)

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Recherche de publications IEC - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

#### IEC online collection - [oc.iec.ch](http://oc.iec.ch)

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Universal serial bus interfaces for data and power –  
Part 1-3: Common components – USB Type-C® Cable and Connector  
Specification**

**Interfaces de bus universel en série pour les données et l'alimentation  
électrique –  
Partie 1-3: Composants communs – Spécification des câbles et connecteurs  
USB Type-C®**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 33.120.20; 33.120.30; 35.200

ISBN 978-2-8322-9337-9

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

# INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

## UNIVERSAL SERIAL BUS INTERFACES FOR DATA AND POWER

### Part 1-3: Common components – USB Type-C® Cable and Connector Specification

#### FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62680-1-3 has been prepared by technical area 18: Multimedia home systems and applications for end-user networks, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

The text of this standard was prepared by the USB Implementers Forum (USB-IF). The structure and editorial rules used in this publication reflect the practice of the organization which submitted it.

The text of this International Standard is based on the following documents:

CDV	Report on voting
100/3439/CDV	100/3501/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

**IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## INTRODUCTION

The IEC 62680 series is based on a series of specifications that were originally developed by the USB Implementers Forum (USB-IF). These specifications were submitted to the IEC under the auspices of a special agreement between the IEC and the USB-IF.

This standard is the USB-IF publication Universal Serial Bus Type-C Cable and Connector Specification Revision 2.0.

The USB Implementers Forum, Inc.(USB-IF) is a non-profit corporation founded by the group of companies that developed the Universal Serial Bus specification. The USB-IF was formed to provide a support organization and forum for the advancement and adoption of Universal Serial Bus technology. The Forum facilitates the development of high-quality compatible USB peripherals (devices), and promotes the benefits of USB and the quality of products that have passed compliance testing.

**ANY USB SPECIFICATIONS ARE PROVIDED TO YOU "AS IS, "WITH NO WARRANTIES WHATSOEVER, INCLUDING ANY WARRANTY OF MERCHANTABILITY, NON-INFRINGEMENT, OR FITNESS FOR ANY PARTICULAR PURPOSE. THE USB IMPLEMENTERS FORUM AND THE AUTHORS OF ANY USB SPECIFICATIONS DISCLAIM ALL LIABILITY, INCLUDING LIABILITY FOR INFRINGEMENT OF ANY PROPRIETARY RIGHTS, RELATING TO USE OR IMPLEMENTATION OR INFORMATION IN THIS SPECIFICATION.**

**THE PROVISION OF ANY USB SPECIFICATIONS TO YOU DOES NOT PROVIDE YOU WITH ANY LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS.**

Entering into USB Adopters Agreements may, however, allow a signing company to participate in a reciprocal, RAND-Z licensing arrangement for compliant products. For more information, please see:

<https://www.usb.org/documents>

IEC DOES NOT TAKE ANY POSITION AS TO WHETHER IT IS ADVISABLE FOR YOU TO ENTER INTO ANY USB ADOPTERS AGREEMENTS OR TO PARTICIPATE IN THE USB IMPLEMENTERS FORUM."

## CONTENTS

Specification Work Group Chairs / Specification Editors .....	19
Specification Work Group Contributors .....	19
Pre-Release Draft Industry Reviewing Companies That Provided Feedback.....	24
Revision History.....	25
1 Introduction .....	26
1.1 Purpose .....	26
1.2 Scope.....	26
1.3 Related Documents .....	27
1.4 Conventions.....	27
1.4.1 Precedence .....	27
1.4.2 Keywords .....	27
1.4.3 Numbering.....	28
1.5 Terms and Abbreviations.....	28
2 Overview .....	33
2.1 Introduction .....	33
2.2 USB Type-C Receptacles, Plugs and Cables.....	34
2.3 Configuration Process .....	35
2.3.1 Source-to-Sink Attach/Detach Detection.....	36
2.3.2 Plug Orientation/Cable Twist Detection.....	36
2.3.3 Initial Power (Source-to-Sink) Detection and Establishing the Data (Host-to-Device) Relationship.....	36
2.3.4 USB Type-C VBUS Current Detection and Usage .....	37
2.3.5 USB PD Communication.....	37
2.3.6 Functional Extensions.....	38
2.4 VBUS.....	38
2.5 VCONN.....	39
2.6 Hubs.....	39
3 Mechanical.....	40
3.1 Overview .....	40
3.1.1 Compliant Connectors.....	40
3.1.2 Compliant Cable Assemblies .....	40
3.1.3 Compliant USB Type-C to Legacy Cable Assemblies.....	40
3.1.4 Compliant USB Type-C to Legacy Adapter Assemblies .....	41
3.2 USB Type-C Connector Mating Interfaces .....	41
3.2.1 Interface Definition .....	42
3.2.2 Reference Designs .....	63
3.2.3 Pin Assignments and Descriptions.....	70
3.3 Cable Construction and Wire Assignments.....	71
3.3.1 Cable Construction (Informative) .....	71
3.3.2 Wire Assignments .....	73
3.3.3 Wire Gauges and Cable Diameters (Informative).....	74
3.4 Standard USB Type-C Cable Assemblies .....	76

3.4.1	USB Full-Featured Type-C Cable Assembly .....	76
3.4.2	USB 2.0 Type-C Cable Assembly.....	77
3.4.3	USB Type-C Captive Cable Assemblies.....	78
3.5	Legacy Cable Assemblies .....	78
3.5.1	USB Type-C to <i>USB 3.1</i> Standard-A Cable Assembly .....	79
3.5.2	USB Type-C to <i>USB 2.0</i> Standard-A Cable Assembly .....	80
3.5.3	USB Type-C to <i>USB 3.1</i> Standard-B Cable Assembly .....	81
3.5.4	USB Type-C to <i>USB 2.0</i> Standard-B Cable Assembly .....	82
3.5.5	USB Type-C to <i>USB 2.0</i> Mini-B Cable Assembly .....	83
3.5.6	USB Type-C to <i>USB 3.1</i> Micro-B Cable Assembly.....	84
3.5.7	USB Type-C to <i>USB 2.0</i> Micro-B Cable Assembly.....	86
3.6	Legacy Adapter Assemblies .....	87
3.6.1	USB Type-C to <i>USB 3.1</i> Standard-A Receptacle Adapter Assembly .....	87
3.6.2	USB Type-C to <i>USB 2.0</i> Micro-B Receptacle Adapter Assembly.....	89
3.7	Electrical Characteristics .....	90
3.7.1	Raw Cable (Informative).....	90
3.7.2	USB Type-C to Type-C Passive Cable Assemblies (Normative).....	91
3.7.3	Mated Connector (Informative – USB 3.2 Gen2 and USB4 Gen2) .....	109
3.7.4	Mated Connector (Normative – USB4 Gen3).....	113
3.7.5	USB Type-C to Legacy Cable Assemblies (Normative).....	114
3.7.6	USB Type-C to USB Legacy Adapter Assemblies (Normative) .....	118
3.7.7	Shielding Effectiveness Requirements (Normative).....	120
3.7.8	DC Electrical Requirements (Normative) .....	122
3.8	Mechanical and Environmental Requirements (Normative).....	125
3.8.1	Mechanical Requirements.....	125
3.8.2	Environmental Requirements .....	130
3.9	Docking Applications (Informative) .....	131
3.10	Implementation Notes and Design Guides .....	132
3.10.1	EMC Management (Informative) .....	132
3.10.2	Stacked and Side-by-Side Connector Physical Spacing (Informative) .....	134
3.10.3	Cable Mating Considerations (Informative).....	135
4	Functional .....	136
4.1	Signal Summary.....	136
4.2	Signal Pin Descriptions .....	136
4.2.1	SuperSpeed USB Pins .....	136
4.2.2	USB 2.0 Pins .....	137
4.2.3	Auxiliary Signal Pins.....	137
4.2.4	Power and Ground Pins .....	137
4.2.5	Configuration Pins .....	137
4.3	Sideband Use (SBU) .....	137
4.4	Power and Ground.....	137
4.4.1	IR Drop .....	137
4.4.2	VBUS .....	138
4.4.3	VCONN.....	141

August 2019

4.5	Configuration Channel (CC).....	145
4.5.1	Architectural Overview .....	145
4.5.2	CC Functional and Behavioral Requirements .....	159
4.5.3	USB Port Interoperability Behavior.....	194
4.6	Power .....	213
4.6.1	Power Requirements during USB Suspend.....	214
4.6.2	VBUS Power Provided Over a USB Type-C Cable .....	215
4.7	USB Hubs .....	220
4.8	Power Sourcing and Charging.....	220
4.8.1	DFP as a Power Source .....	221
4.8.2	Non-USB Charging Methods .....	223
4.8.3	Sinking Host .....	224
4.8.4	Sourcing Device.....	224
4.8.5	Charging a System with a Dead Battery .....	224
4.8.6	USB Type-C Multi-Port Chargers .....	224
4.9	Electronically Marked Cables.....	227
4.9.1	Parameter Values .....	228
4.9.2	Active Cables.....	229
4.10	VCONN-Powered Accessories (VPAs) and VCONN-Powered USB Devices (VPDs).....	229
4.10.1	VCONN-Powered Accessories (VPAs).....	229
4.10.2	VCONN-Powered USB Devices (VPDs) .....	229
4.11	Parameter Values.....	231
4.11.1	Termination Parameters .....	231
4.11.2	Timing Parameters.....	233
4.11.3	Voltage Parameters.....	236
5	USB4 Discovery and Entry .....	238
5.1	Overview of the Discovery and Entry Process.....	238
5.2	USB4 Functional Requirements.....	239
5.2.1	USB4 Host Functional Requirements .....	239
5.2.2	USB4 Device Functional Requirements .....	239
5.2.3	USB4 Alternate Mode Support.....	239
5.2.3.1	USB4 Alternate Mode Support on Hosts.....	239
5.2.3.2	USB4 Alternate Mode Support on Hubs and USB4-based Docks.....	239
5.3	USB4 Power Requirements.....	240
5.3.1	Source Power Requirements.....	240
5.3.2	Sink Power Requirements .....	240
5.3.3	Device Power Management Requirements .....	240
5.4	USB4 Discovery and Entry Flow Requirements .....	241
5.4.1	USB Type-C Initial Connection .....	241
5.4.2	USB Power Delivery Contract.....	241
5.4.3	USB4 Discovery and Entry Flow .....	241
5.4.3.1	USB4 Device Discovery (SOP).....	242
5.4.3.2	USB4 Cable Discovery (SOP') .....	243
5.4.3.3	USB4 Operational Entry .....	245

5.4.4	USB4 Post-Entry Operation.....	245
5.4.4.1	During USB4 Operation .....	245
5.4.4.2	Exiting USB4 Operation .....	245
5.5	USB4 Hub Connection Requirements .....	246
5.5.1	USB4 Hub Port Initial Connection Requirements.....	246
5.5.2	USB4 Hub UFP and Host Capabilities Discovery.....	246
5.5.3	Hub DFP Connection Requirements.....	247
5.5.3.1	Speculative Connections .....	247
5.5.3.2	Operational Connections.....	247
5.5.4	Hub Ports Connection Behavior Flow Model .....	247
5.5.5	Connecting to Downstream USB4 Hubs.....	253
5.5.6	Fallback Functional Requirements for USB4 Hubs .....	253
5.6	USB4 Device Connection Requirements .....	254
5.6.1	Fallback Mapping of USB4 Peripheral Functions to USB Device Class Types..	254
5.7	Parameter Values.....	255
5.7.1	Timing Parameters.....	255
6	Active Cables.....	256
6.1	USB Type-C State Machine .....	257
6.2	USB PD Requirements .....	258
6.2.1	Active Cable USB PD Requirements .....	259
6.2.2	USB PD Messages for OIAC .....	259
6.2.3	Short Active Cable Behaviors in Response to Power Delivery Events .....	271
6.3	OIAC Connection Flow and State Diagrams .....	271
6.3.1	OIAC Connection Flow – Discovery – Phase 1 .....	272
6.3.2	OIAC Connection Flow – Reboot – Phase 2.....	273
6.3.3	OIAC Connection Flow – Configuration – Phase 3.....	274
6.3.4	OIAC Connection State Diagram Master .....	277
6.3.5	OIAC Connection State Diagram Slave .....	285
6.4	Active Cable Power Requirements .....	290
6.4.1	VBUS Requirements .....	290
6.4.2	OIAC VBUS Requirements.....	290
6.4.3	USB PD Rules in Active State .....	291
6.4.4	VCONN Requirements .....	292
6.5	Mechanical .....	293
6.5.1	Thermal .....	293
6.5.2	Plug Spacing.....	293
6.6	Electrical Requirements .....	294
6.6.1	Shielding Effectiveness Requirement.....	294
6.6.2	Low Speed Signal Requirement.....	294
6.6.3	USB 2.0.....	294
6.6.4	USB 3.2.....	295
6.6.5	Return Loss .....	301
6.7	Active Cables That Support Alternate Modes.....	302
6.7.1	Discover SVIDs .....	302

August 2019

6.7.2	Discover Modes .....	302
6.7.3	Enter/Exit Modes .....	302
6.7.4	Power in Alternate Modes .....	302
A	Audio Adapter Accessory Mode .....	303
A.1	Overview .....	303
A.2	Detail .....	303
A.3	Electrical Requirements .....	304
A.4	Example Implementations .....	306
A.4.1	Passive 3.5 mm to USB Type-C Adapter – Single Pole Detection Switch .....	306
A.4.2	3.5 mm to USB Type-C Adapter Supporting 500 mA Charge-Through .....	306
B	Debug Accessory Mode .....	308
B.1	Overview .....	308
B.2	Functional .....	308
B.2.1	Signal Summary .....	309
B.2.2	Port Interoperability .....	309
B.2.3	Debug Accessory Mode Entry .....	309
B.2.4	Connection State Diagrams .....	310
B.2.5	DTS Port Interoperability Behavior .....	318
B.2.6	Orientation Detection .....	327
B.3	Security/Privacy Requirements: .....	328
C	USB Type-C Digital Audio .....	329
C.1	Overview .....	329
C.2	USB Type-C Digital Audio Specifications .....	329
D	Thermal Design Considerations for Active Cables .....	331
D.1	Introduction .....	331
D.2	Model .....	331
D.2.1	Assumptions .....	331
D.2.2	Model Architecture .....	332
D.2.3	Heat Sources .....	333
D.2.4	Heat Flow .....	333
D.3	USB 3.2 Single Lane Active Cable .....	334
D.3.1	USB 3.2 Single-Lane Active Cable Design Considerations .....	334
D.4	Dual-Lane Active Cables .....	337
D.4.1	USB 3.2 Dual-Lane Active Cable Design Considerations .....	337
D.4.2	USB 3.2 Dual-Lane Active Cable in a Multi-Port Configuration .....	339
D.5	USB 3.2 Host and Device Design Considerations .....	341
D.5.1	Heat Spreading or Heat Sinking from Host or Device .....	341
D.5.2	Motherboard Temperature Control .....	342
D.5.3	Wider Port Spacing for Multi-Port Applications .....	342
D.5.4	Power Policies .....	342
E	Alternate Modes .....	343
E.1	Alternate Mode Architecture .....	343
E.2	Alternate Mode Requirements .....	343
E.2.1	Alternate Mode Pin Reassignment .....	344

E.2.2	Alternate Mode Electrical Requirements .....	344
E.3	Parameter Values.....	347
E.4	Example Alternate Mode – USB DisplayPort™ Dock .....	348
E.4.1	USB DisplayPort™ Dock Example .....	348
E.4.2	Functional Overview .....	349
E.4.3	Operational Summary .....	350
F	Thunderbolt 3 Compatibility Discovery and Entry .....	351
F.1	TBT3 Compatibility Mode Functional Requirements .....	351
F.1.1	TBT3-Compatible Power Requirements.....	351
F.1.2	TBT3-Compatible Host Requirements .....	351
F.1.3	TBT3-Compatible Device Upstream Requirements .....	351
F.1.4	TBT3-Compatible Device Downstream Requirements.....	351
F.1.5	TBT3-Compatible Self-Powered Device Without Predefined Upstream Port Rules.....	352
F.1.6	TBT3-Compatible Devices with a Captive Cable .....	352
F.2	TBT3 Discovery and Entry Flow .....	352
F.2.1	TBT3 Passive Cable Discover Identity Responses.....	354
F.2.2	TBT3 Active Cable Discover Identity Responses .....	356
F.2.3	TBT3 Device Discover Identity Responses .....	359
F.2.4	TBT3 Discover SVID Responses .....	360
F.2.5	TBT3 Device Discover Mode Responses .....	361
F.2.6	TBT3 Cable Discover Mode Responses .....	362
F.2.7	TBT3 Cable Enter Mode Command .....	363
F.2.8	TBT3 Device Enter Mode Command.....	364
F.2.9	TBT3 Cable Functional Difference Summary .....	365

## FIGURES

Figure 2-1	USB Type-C Receptacle Interface (Front View).....	33
Figure 2-2	USB Full-Featured Type-C Plug Interface (Front View) .....	34
Figure 3-1	USB Type-C Receptacle Interface Dimensions.....	44
Figure 3-2	Reference Design USB Type-C Plug External EMC Spring Contact Zones.....	47
Figure 3-3	USB Full-Featured Type-C Plug Interface Dimensions.....	48
Figure 3-4	Reference Footprint for a USB Type-C Vertical Mount Receptacle (Informative) .....	51
Figure 3-5	Reference Footprint for a USB Type-C Dual-Row SMT Right Angle Receptacle (Informative) .....	52
Figure 3-6	Reference Footprint for a USB Type-C Hybrid Right-Angle Receptacle (Informative).....	53
Figure 3-7	Reference Footprint for a USB Type-C Mid-Mount Dual-Row SMT Receptacle (Informative) .....	54
Figure 3-8	Reference Footprint for a USB Type-C Mid-Mount Hybrid Receptacle (Informative).....	55
Figure 3-9	Reference Footprint for a USB 2.0 Type-C Through Hole Right Angle Receptacle (Informative) .....	56
Figure 3-10	Reference Footprint for a USB 2.0 Type-C Single Row Right Angle Receptacle (Informative) .....	57
Figure 3-11	USB 2.0 Type-C Plug Interface Dimensions.....	59
Figure 3-12	USB Type-C Plug EMC Shielding Spring Tip Requirements.....	62
Figure 3-13	Reference Design of Receptacle Mid-Plate.....	63
Figure 3-14	Reference Design of the Retention Latch.....	64

Figure 3-15	Illustration of the Latch Soldered to the Paddle Card Ground .....	64
Figure 3-16	Reference Design of the USB Full-Featured Type-C Plug Internal EMC Spring.....	65
Figure 3-17	Reference Design of the <i>USB 2.0</i> Type-C Plug Internal EMC Spring .....	66
Figure 3-18	Reference Design of Internal EMC Pad .....	67
Figure 3-19	Reference Design of a USB Type-C Receptacle with External EMC Springs .....	68
Figure 3-20	Reference Design for a USB Full-Featured Type-C Plug Paddle Card .....	69
Figure 3-21	Illustration of a USB Full-Featured Type-C Cable Cross Section, a Coaxial Wire Example with VCONN.....	72
Figure 3-22	Illustration of a USB Full-Featured Type-C Cable Cross Section, a Coaxial Wire Example without VCONN.....	72
Figure 3-23	USB Full-Featured Type-C Standard Cable Assembly.....	76
Figure 3-24	USB Type-C to USB 3.1 Standard-A Cable Assembly .....	79
Figure 3-25	USB Type-C to <i>USB 2.0</i> Standard-A Cable Assembly.....	80
Figure 3-26	USB Type-C to <i>USB 3.1</i> Standard-B Cable Assembly.....	81
Figure 3-27	USB Type-C to <i>USB 2.0</i> Standard-B Cable Assembly.....	82
Figure 3-28	USB Type-C to <i>USB 2.0</i> Mini-B Cable Assembly.....	83
Figure 3-29	USB Type-C to <i>USB 3.1</i> Micro-B Cable Assembly.....	84
Figure 3-30	USB Type-C to <i>USB 2.0</i> Micro-B Cable Assembly.....	86
Figure 3-31	USB Type-C to <i>USB 3.1</i> Standard-A Receptacle Adapter Assembly.....	87
Figure 3-32	USB Type-C to <i>USB 2.0</i> Micro-B Receptacle Adapter Assembly.....	89
Figure 3-33	Illustration of Test Points for a Mated Cable Assembly .....	91
Figure 3-34	Recommended Differential Insertion Loss Requirement (USB 3.2 Gen2 and USB4 Gen2).....	92
Figure 3-35	Recommended Differential Return Loss Requirement .....	92
Figure 3-36	Recommended Differential Crosstalk Requirement.....	93
Figure 3-37	Recommended Differential Near-End and Far-End Crosstalk Requirement between USB D+/D- Pair and TX/RX Pair.....	94
Figure 3-38	Recommended Differential Insertion Loss Requirement (USB4 Gen3).....	94
Figure 3-39	Illustration of Insertion Loss Fit at Nyquist Frequency .....	95
Figure 3-40	Input Pulse Spectrum .....	96
Figure 3-41	IMR Limit as Function of ILfitatNq .....	97
Figure 3-42	IRL Limit as Function of ILfitatNq .....	99
Figure 3-43	Differential-to-Common-Mode Conversion Requirement .....	99
Figure 3-44	IMR Limit as Function of ILfit at 10 GHz (USB4 Gen3) .....	100
Figure 3-45	Definition of Port, Victim, and Aggressor .....	101
Figure 3-46	I <sub>XT_DP</sub> and I <sub>XT_USB</sub> Limit as Function of ILfit at 10 GHz (USB4 Gen3).....	101
Figure 3-47	IRL Limit as Function of ILfitatNq (USB4 Gen3) .....	102
Figure 3-48	Differential-to-Common-Mode Conversion Requirement (USB4 Gen3).....	102
Figure 3-49	Cable Assembly in System .....	103
Figure 3-50	Requirement for Differential Coupling between CC and D+/D- .....	105
Figure 3-51	Requirement for Single-Ended Coupling between CC and D- in USB 2.0 Type-C Cables.....	105
Figure 3-52	Requirement for Single-Ended Coupling between CC and D- in USB Full-Featured Type-C Cables .....	106
Figure 3-53	Requirement for Differential Coupling between VBUS and D+/D-.....	106
Figure 3-54	Requirement for Single-Ended Coupling between SBU_A and SBU_B.....	107
Figure 3-55	Requirement for Single-Ended Coupling between SBU_A/SBU_B and CC .....	108
Figure 3-56	Requirement for Coupling between SBU_A and differential D+/D-, and SBU_B and differential D+/D-.....	108
Figure 3-57	Illustration of USB Type-C Mated Connector.....	109
Figure 3-58	Recommended Impedance Limits of a USB Type-C Mated Connector .....	110
Figure 3-59	Recommended Ground Void Dimensions for USB Type-C Receptacle.....	111
Figure 3-60	Recommended Differential Near-End and Far-End Crosstalk Limits between D+/D- Pair and TX/RX Pairs .....	112
Figure 3-61	Recommended Limits for Differential-to-Common-Mode Conversion.....	113
Figure 3-62	IMR Limit as Function of ILfitatNq for USB Type-C to Legacy Cable Assembly .....	117
Figure 3-63	IRL Limit as Function of ILfitatNq for USB Type-C to Legacy Cable Assembly .....	117
Figure 3-64	Cable Assembly Shielding Effectiveness Testing .....	120

Figure 3-65 Shielding Effectiveness Pass/Fail Criteria .....	121
Figure 3-66 LLCR Measurement Diagram .....	122
Figure 3-67 Temperature Measurement Point .....	123
Figure 3-68 Example Current Rating Test Fixture Trace Configuration.....	124
Figure 3-69 Example of 4-Axis Continuity Test Fixture .....	126
Figure 3-70 Example Wrenching Strength Test Fixture for Plugs without Overmold .....	128
Figure 3-71 Reference Wrenching Strength Continuity Test Fixture .....	129
Figure 3-72 Example of Wrenching Strength Test Mechanical Failure Point.....	129
Figure 3-73 Wrenching Strength Test with Cable in Fixture .....	130
Figure 3-74 USB Type-C Cable Receptacle Flange Example .....	132
Figure 3-75 EMC Guidelines for Side Latch and Mid-plate .....	133
Figure 3-76 EMC Finger Connections to Plug Shell .....	133
Figure 3-77 EMC Pad Connections to Receptacle Shell .....	134
Figure 3-78 Examples of Connector Apertures .....	134
Figure 3-79 Recommended Minimum Spacing between Connectors .....	135
Figure 3-80 Recommended Minimum Plug Overmold Clearance.....	135
Figure 3-81 Cable Plug Overmold and an Angled Surface .....	135
Figure 4-1 Cable IR Drop .....	138
Figure 4-2 Cable IR Drop for powered cables.....	138
Figure 4-3 Logical Model for Single-Lane Data Bus Routing across USB Type-C-based Ports .....	147
Figure 4-4 Logical Model for USB Type-C-based Ports for a Single-Lane Direct Connect Device .....	147
Figure 4-5 Pull-Up/Pull-Down CC Model.....	149
Figure 4-6 Current Source/Pull-Down CC Model.....	149
Figure 4-7 Source Functional Model for CC1 and CC2 .....	152
Figure 4-8 Source Functional Model Supporting USB PD PR_Swap.....	153
Figure 4-9 Sink Functional Model for CC1 and CC2.....	153
Figure 4-10 Sink Functional Model Supporting USB PD PR_Swap and VCONN_Swap.....	154
Figure 4-11 DRP Functional Model for CC1 and CC2.....	155
Figure 4-12 Connection State Diagram: Source .....	160
Figure 4-13 Connection State Diagram: Sink .....	161
Figure 4-14 Connection State Diagram: Sink with Accessory Support.....	162
Figure 4-15 Connection State Diagram: DRP .....	163
Figure 4-16 Connection State Diagram: DRP with Accessory and Try_SRC Support.....	164
Figure 4-17 Connection State Diagram: DRP with Accessory and Try_SNK Support .....	165
Figure 4-18 Connection State Diagram: Charge-Through VPD .....	166
Figure 4-19 Sink Power Sub-States .....	189
Figure 4-20 Cable eMarker State Diagram .....	190
Figure 4-21 Source to Sink Functional Model.....	194
Figure 4-22 Source to DRP Functional Model.....	195
Figure 4-23 DRP to Sink Functional Model .....	196
Figure 4-24 DRP to DRP Functional Model – CASE 1.....	197
Figure 4-25 DRP to DRP Functional Model – CASE 2 & 3 .....	198
Figure 4-26 Source to Source Functional Model.....	200
Figure 4-27 Sink to Sink Functional Model .....	201
Figure 4-28 DRP to VPD Model.....	201
Figure 4-29 Example DRP to Charge-Through VCONN-Powered USB Device Model.....	202
Figure 4-30 Source to Legacy Device Port Functional Model .....	210
Figure 4-31 Legacy Host Port to Sink Functional Model.....	211
Figure 4-32 DRP to Legacy Device Port Functional Model.....	212
Figure 4-33 Legacy Host Port to DRP Functional Model.....	213
Figure 4-34 Sink Monitoring for Current in Pull-Up/Pull-Down CC Model.....	216
Figure 4-35 Sink Monitoring for Current in Current Source/Pull-Down CC Model.....	217
Figure 4-36 USB PD over CC Pins .....	217
Figure 4-37 USB PD BMC Signaling over CC .....	218

Figure 4-38 USB Type-C Cable's Output as a Function of Load for Non-PD-based USB Type-C Charging .....	222
Figure 4-39 0 – 3 A USB PD-based Charger USB Type-C Cable's Output as a Function of Load .....	223
Figure 4-40 3 – 5 A USB PD-based Charger USB Type-C Cable's Output as a Function of Load .....	223
Figure 4-41 Electronically Marked Cable with VCONN connected through the cable .....	228
Figure 4-42 Electronically Marked Cable with SOP' at both ends .....	228
Figure 4-43 Example Charge-Through VCONN-Power USB Device Use Case .....	231
Figure 4-44 DRP Timing .....	234
Figure 5-1 USB4 Discovery and Entry Flow Model .....	242
Figure 5-2 USB4 Hub with USB4 Host and Device Connection Flow Alignment .....	248
Figure 5-3 USB4 Hub with USB 3.2 Host and USB4 Device Host Connection Flow Model .....	249
Figure 5-4 USB4 Hub with USB4 Host and USB 3.2 Device Connection Flow Model .....	250
Figure 5-5 USB4 Hub with USB 3.2 Host and Device Connection Flow Model .....	251
Figure 5-6 USB4 Hub with USB4 Host and DP Alt Mode Device Connection Flow Model .....	252
Figure 5-7 USB4 Hub with USB 3.2 Host and DP Alt Mode Device Connection Flow Model .....	253
Figure 6-1 Electronically Marked Short Active Cable with SOP' Only .....	258
Figure 6-2 Electronically Marked Short Active Cable with SOP' and SOP" .....	258
Figure 6-3 Electronically Marked Optically Isolated Active Cable .....	259
Figure 6-4 OIAC USB PD Message Forwarding .....	265
Figure 6-5 OIAC Successful Data Role Swap .....	268
Figure 6-6 OIAC Rejected Data Role Swap .....	269
Figure 6-7 OIAC Wait Data Role Swap .....	269
Figure 6-8 OIAC Initiator Reject Data Role Swap .....	270
Figure 6-9 OIAC Initiator Wait Data Role Swap .....	271
Figure 6-10 OIAC Discovery – Phase 1 .....	273
Figure 6-11 OIAC Reboot – Phase 2 .....	274
Figure 6-12 OIAC Master Plug Configure as DFP – Phase 3 .....	275
Figure 6-13 OIAC Master Plug Configure as UFP – Phase 3 .....	276
Figure 6-14 OIAC Master Plug No Connection Possible Billboard – Phase 3 .....	277
Figure 6-15 OIAC Master Plug State Diagram Part 1 (Phase 1 and 2) .....	278
Figure 6-16 OIAC Master Plug State Diagram Part 2 (Phase 3) .....	279
Figure 6-17 OIAC Slave Plug State Diagram .....	286
Figure 6-18 Active Cable Topologies .....	295
Figure 6-19 Illustrations of Usages for OIAC That Require an Adapter or Hub .....	298
Figure 6-20 SuperSpeed USB Electrical Test Points .....	299
Figure 6-21 SuperSpeed USB Compliance Test Setup .....	299
Figure A-1 Example Passive 3.5 mm to USB Type-C Adapter .....	306
Figure A-2 Example 3.5 mm to USB Type-C Adapter Supporting 500 mA Charge-Through .....	307
Figure B-1 USB Type-C Debug Accessory Layered Behavior .....	308
Figure B-2 DTS Plug Interface .....	309
Figure B-3 Connection State Diagram: DTS Source .....	310
Figure B-4 Connection State Diagram: DTS Sink .....	311
Figure B-5 Connection State Diagram: DTS DRP .....	312
Figure B-6 TS Sink Power Sub-States .....	316
Figure D-1 Active Cable Model (Single Port, Top Mount Receptacle) .....	332
Figure D-2 Model Architecture .....	332
Figure D-3 Heat Sources and Heat Flow Paths .....	333
Figure D-4 Vertically Stacked Horizontal Connectors 3x1 Configuration (VERT) .....	335
Figure D-5 Horizontally Stacked Vertical Connectors 1x3 Configuration (HZ90) .....	335
Figure D-6 Horizontally Stacked Horizontal Connector 1x3 Configuration (HORZ) .....	335
Figure D-7 USB 3.2 Single-Lane 3A Active Cable in a 3-Port Configuration .....	336
Figure D-8 USB 3.2 Single-Lane 5A Active Cable in a 3-Port Configuration .....	337
Figure D-9 Impact of Over-mold Power $P_0$ and Thermal Boundary Temperature $T_{MB}$ at 3 A VBUS in a Single Port Configuration .....	338
Figure D-10 Impact of Over-mold Power $P_0$ and Thermal Boundary Temperature $T_{MB}$ at 5 A VBUS in a Single Port Configuration .....	339

Figure D-11 USB 3.2 Active Cable Dongle Design (One End Shown).....	339
Figure D-12 USB 3.2 Dual-Lane 3A Active Cable in a 3-Port Configuration .....	340
Figure D-13 USB 3.2 Dual-Lane 5A Active Cable in a 3-Port Configuration .....	341
Figure D-14 Example: Additional Heat Spreader on Receptacle in Host or Device .....	342
Figure D-15 Example: Heat Sinking by Chassis of Host or Device .....	342
Figure E-1 Pins Available for Reconfiguration over the Full-Featured Cable.....	344
Figure E-2 Pins Available for Reconfiguration for Direct Connect Applications.....	344
Figure E-3 Alternate Mode Implementation using a USB Type-C to USB Type-C Cable .....	346
Figure E-4 Alternate Mode Implementation using a USB Type-C to Alternate Mode Cable or Device.....	347
Figure E-5 USB DisplayPort Dock Example.....	349
Figure F-1 TBT3 Discovery Flow .....	353

## TABLES

Table 2-1 Summary of power supply options.....	38
Table 3-1 USB Type-C Standard Cable Assemblies.....	40
Table 3-2 USB Type-C Legacy Cable Assemblies .....	41
Table 3-3 USB Type-C Legacy Adapter Assemblies.....	41
Table 3-4 USB Type-C Receptacle Interface Pin Assignments.....	70
Table 3-5 USB Type-C Receptacle Interface Pin Assignments for USB 2.0-only Support.....	71
Table 3-6 USB Type-C Standard Cable Wire Assignments .....	73
Table 3-7 USB Type-C Cable Wire Assignments for Legacy Cables/Adapters .....	74
Table 3-8 Reference Wire Gauges for standard USB Type-C Cable Assemblies .....	75
Table 3-9 Reference Wire Gauges for USB Type-C to Legacy Cable Assemblies .....	75
Table 3-10 USB Full-Featured Type-C Standard Cable Assembly Wiring .....	77
Table 3-11 USB 2.0 Type-C Standard Cable Assembly Wiring.....	78
Table 3-12 USB Type-C to USB 3.1 Standard-A Cable Assembly Wiring.....	79
Table 3-13 USB Type-C to USB 2.0 Standard-A Cable Assembly Wiring.....	80
Table 3-14 USB Type-C to USB 3.1 Standard-B Cable Assembly Wiring .....	81
Table 3-15 USB Type-C to USB 2.0 Standard-B Cable Assembly Wiring .....	82
Table 3-16 USB Type-C to USB 2.0 Mini-B Cable Assembly Wiring.....	83
Table 3-17 USB Type-C to USB 3.1 Micro-B Cable Assembly Wiring .....	85
Table 3-18 USB Type-C to USB 2.0 Micro-B Cable Assembly Wiring .....	86
Table 3-19 USB Type-C to USB 3.1 Standard-A Receptacle Adapter Assembly Wiring .....	88
Table 3-20 USB Type-C to USB 2.0 Micro-B Receptacle Adapter Assembly Wiring .....	89
Table 3-21 Differential Insertion Loss Examples for TX/RX with Twisted Pair Construction .....	90
Table 3-22 Differential Insertion Loss Examples for USB TX/RX with Coaxial Construction.....	91
Table 3-23 Key Parameters in COM Configuration File.....	103
Table 3-24 Electrical Requirements for CC and SBU wires.....	104
Table 3-25 Coupling Matrix for Low Speed Signals.....	104
Table 3-26 Maximum Mutual Inductance (M) between VBUS and Low Speed Signal Lines .....	107
Table 3-27 USB D+/D- Signal Integrity Requirements for USB Type-C to USB Type-C Passive Cable Assemblies .....	109
Table 3-28 USB Type-C Mated Connector Recommended Signal Integrity Characteristics (Informative) .....	111
Table 3-29 USB Type-C Mated Connector Signal Integrity Characteristics for USB4 Gen3 (Normative).....	113
Table 3-30 USB D+/D- Signal Integrity Requirements for USB Type-C to Legacy USB Cable Assemblies .....	115
Table 3-31 Design Targets for USB Type-C to USB 3.1 Gen2 Legacy Cable Assemblies (Informative).....	115
Table 3-32 USB Type-C to USB 3.1 Gen2 Legacy Cable Assembly Signal Integrity Requirements (Normative) .....	116
Table 3-33 USB D+/D- Signal Integrity Requirements for USB Type-C to Legacy USB Adapter Assemblies (Normative).....	118
Table 3-34 Design Targets for USB Type-C to USB 3.1 Standard-A Adapter Assemblies (Informative).....	119

Table 3-35 USB Type-C to USB 3.1 Standard-A Receptacle Adapter Assembly Signal Integrity Requirements (Normative).....	119
Table 3-36 Current Rating Test PCB.....	124
Table 3-37 Maximum DC Resistance Requirement (Normative).....	124
Table 3-38 Force and Moment Requirements.....	127
Table 3-39 Environmental Test Conditions.....	130
Table 3-40 Reference Materials.....	131
Table 4-1 USB Type-C List of Signals.....	136
Table 4-2 VBUS Source Characteristics.....	139
Table 4-3 VBUS Sink Characteristics.....	140
Table 4-4 USB Type-C Source Port's VCONN Requirements Summary.....	141
Table 4-5 VCONN Source Characteristics.....	142
Table 4-6 Cable VCONN Sink Characteristics.....	143
Table 4-7 VCONN-Powered Accessory (VPA) Sink Characteristics.....	144
Table 4-8 VCONN-Powered USB Device (VPD) Sink Characteristics.....	145
Table 4-9 USB Type-C-based Port Interoperability.....	148
Table 4-10 Source Perspective.....	150
Table 4-11 Source (Host) and Sink (Device) Behaviors by State.....	151
Table 4-12 USB PD Swapping Port Behavior Summary.....	157
Table 4-13 Power Role Behavioral Model Summary.....	158
Table 4-14 Source Port CC Pin State.....	167
Table 4-15 Sink Port CC Pin State.....	167
Table 4-16 Mandatory and Optional States.....	192
Table 4-17 Precedence of power source usage.....	214
Table 4-18 USB Type-C Current Advertisement and PDP Equivalent.....	216
Table 4-19 Precedence of power source usage.....	219
Table 4-20 Example Charge-Through VPD Sink Maximum Currents based on VBUS Impedance and GND Impedance.....	220
Table 4-21 SOP' and SOP'' Timing.....	228
Table 4-22 Charge-Through VPD CC Impedance (RccCON) Requirements.....	230
Table 4-23 CTVPD Charge-Through Port VBUS Bypass Requirements.....	230
Table 4-24 Source CC Termination (Rp) Requirements.....	231
Table 4-25 Sink CC Termination (Rd) Requirements.....	232
Table 4-26 Powered Cable Termination Requirements.....	232
Table 4-27 CC Termination Requirements for Disabled state, ErrorRecovery state, and Unpowered Source.....	232
Table 4-28 SBU Termination Requirements.....	232
Table 4-29 VBUS and VCONN Timing Parameters.....	233
Table 4-30 DRP Timing Parameters.....	234
Table 4-31 CC Timing.....	235
Table 4-32 CC Voltages on Source Side – Default USB.....	236
Table 4-33 CC Voltages on Source Side – 1.5 A @ 5 V.....	236
Table 4-34 CC Voltages on Source Side – 3.0 A @ 5 V.....	237
Table 4-35 Voltage on Sink CC Pins (Default USB Type-C Current only).....	237
Table 4-36 Voltage on Sink CC pins (Multiple Source Current Advertisements).....	237
Table 5-1 Certified Cables Where USB4-compatible Operation is Expected.....	243
Table 5-2 Fallback Mapping USB4 Peripheral Functions to USB Device Class Types.....	254
Table 5-3 USB Billboard Device Class Availability Following USB4 Device Entry Failure.....	255
Table 6-1 Comparison of Active Cables.....	257
Table 6-2 Summary of Active Cable Features.....	257
Table 6-3 OIAC USB PD Message Behavior on Initial Connection.....	260
Table 6-4 OIAC USB PD Messages Which Do Not Traverse in Active State.....	262
Table 6-5 OIAC USB PD Messages Addressed to SOP Which Traverse the OIAC in the Active State.....	264
Table 6-6 OIAC USB PD Message Timing.....	265
Table 6-7 OIAC SOP Messages Which Terminate at the Cable Plug.....	266
Table 6-8 Port and Plug Capabilities.....	272

Table 6-9	OIAC Sink_Capabilities PDO (SOP) on Initial Connection .....	290
Table 6-10	OIAC Sink_Capabilities_Extended PDO (SOP) on Initial Connection .....	291
Table 6-11	OIAC Sink RDO (SOP) on Initial Connection.....	291
Table 6-12	OIAC Active Sink RDO (SOP) .....	292
Table 6-13	OIAC Sink_Capabilities PDO (SOP) in Active .....	292
Table 6-14	Cable Temperature Requirements .....	293
Table 6-15	Summary of Active Cable Features .....	294
Table 6-16	Active Cable Power-on Requirements .....	296
Table 6-17	OIAC Maximum USB 3.2 U0 Delay .....	297
Table 6-18	Usages for OIAC That Require an Adapter or Hub .....	297
Table 6-19	USB 3.2 U-State Requirements.....	298
Table 6-20	Active Cable USB 3.2 Stressed Source Swing, TP1 .....	300
Table 6-21	Active Cable USB 3.2 Stressed Source Jitter, TP1.....	300
Table 6-22	Active Cable USB 3.2 Input Swing at TP2 (Informative).....	301
Table 6-23	Active Cable USB 3.2 Output Swing at TP3 (Informative) .....	301
Table A-1	USB Type-C Analog Audio Pin Assignments.....	304
Table A-2	USB Type-C Analog Audio Pin Electrical Parameter Ratings .....	305
Table B-1	DTS to TS Port Interoperability.....	309
Table B-2	Rp/Rp Charging Current Values for a DTS Source.....	316
Table B-3	Mandatory and Optional States.....	318
Table D-1	Heat Sources and Heat Dissipation Example (1.5 W cable and 5 A) .....	334
Table D-2	USB 3.2 Active Cable Design Single Port Case Study at 35 °C Ambient and 60 °C Thermal Boundary (Single Lane) .....	334
Table D-3	USB 3.2 Active Cable Design Single Port Case Study at 35 °C Ambient and 60 °C Thermal Boundary (Dual Lane) .....	338
Table E-1	USB Safe State Electrical Requirements .....	347
Table E-2	USB Billboard Device Class Availability Following Alternate Mode Entry Failure.....	348
Table E-3	Alternate Mode Signal Noise Ingression Requirements.....	348
Table F-1	TBT3 Passive Cable Discover Identity VDO Responses .....	354
Table F-2	TBT3 Passive Cable VDO for USB PD Revision 2.0, Version 1.3 .....	355
Table F-3	TBT3 Passive Cable VDO for USB PD Revision 3.0, Version 1.2 .....	355
Table F-4	TBT3 Active Cable Discover Identity VDO Responses.....	356
Table F-5	TBT3 Active Cable VDO for USB PD Revision 2.0, Version 1.3.....	357
Table F-6	TBT3 Active Cable VDO 1 for USB PD Revision 3.0, Version 1.2 .....	357
Table F-7	TBT3 Active Cable VDO 2 for USB PD Revision 3.0, Version 1.2 .....	358
Table F-8	TBT3 Device Discover Identity VDO Responses .....	359
Table F-9	TBT3 Discover SVID VDO Responses.....	360
Table F-10	TBT3 Device Discover Mode VDO Responses .....	361
Table F-11	TBT3 Cable Discover Mode VDO Responses.....	362
Table F-12	TBT3 Cable Enter Mode Command .....	363
Table F-13	TBT3 Device Enter Mode Command.....	364
Table F-14	TBT3 Cable Functional Difference Summary.....	365

**Specification Work Group Chairs / Specification Editors**

Intel Corporation (USB Promoter company)	Yun Ling – Mechanical WG co-chair, Mechanical Chapter Co-editor Brad Saunders – Plenary/Functional WG chair, Specification Co-author
Renesas Electronics Corp. (USB Promoter company)	Bob Dunstan – Functional WG co-chair, Specification Co-author
Seagate	Alvin Cox, Mechanical WG co-chair, Mechanical Chapter Co-editor

**Specification Work Group Contributors**

Note: For historical reasons, the following list also includes individual contributors that were members of the work group and associated with their company affiliations at the time of the original Release 1.0 and Release 2.0.

Advanced-Connectek, Inc. (ACON)	Victory Chen	Conrad Choy	Alan Tsai	
	Glen Chandler	Vicky Chuang	Wayne Wang	
	Dennis Cheung	Jessica Feng	Stephen Yang	
	Jeff Chien	Aven Kao	Sunney Yang	
	Lee (Dick Lee) Ching	Danny Liao		
Advanced Micro Devices	Steve Capezza	Jason Hawken	Joseph Scanlon	
	Walter Fry	Tim Perley	Peter Teng	
	Will Harris			
Allion Labs, Inc.	Howard Chang	Brian Shih	Chester Tsai	
	Minoru Ohara			
Amphenol AssembleTech (Xiamen) Co., Ltd.	Louis Chan	Martin Li	Alan Yang	
	Jesse Jaramillo	Lino Liu		
	Terry Ke	Shawn Wei		
Amphenol Corporation	Zhineng Fan			
Agilent Technologies, Inc.	James Choate			
Analogix Semiconductor, Inc.	Mehran Badii	Haijian Sui	Yueke Tang	
	Greg Stewart			
Apple Inc. (USB Promoter company)	Colin Abraham	Zheng Gao	James Orr	
	Mahmoud Amini	Derek Iwamoto	Keith Porthouse	
	Sree Anantharaman	Scott Jackson	Breton Saunders	
	Brian Baek	Girault Jones	Reese Schreiber	
	Paul Baker	Keong Kam	Sascha Tietz	
	Michael Bonham	Kevin Keeler	Jennifer Tsai	
	Carlos Calderon	Min Kim	Colin Whitby-Strevens	
	Jason Chung	Woopoung Kim	Jeff Wilcox	
	David Conroy	Alexei Kosut	Eric Wiles	
	Bill Cornelius	Christine Krause	Dan Wilson	
	Christophe Daniel	Chris Ligtenberg	Dennis Yarak	
	William Ferry	Matthew Mora		
	Brian Follis	Nathan Ng		
	Bizlink Technology, Inc.	Alex Chou	Morphy Hsieh	

Cadence Design Systems, Inc.	Marcin Behrendt Huzaifa Dalal Pawel Eichler Sathish Kumar Ganesan	Dariusz Kaczmarczyk Tomasz Klimek Jie Min Asila Nahas Uyen Nguyen	Neelabh Singh Michal Staworko Fred Stivers Mark Summers Claire Ying
Canova Tech	Piergiorgio Beruto Andrea Maniero	Michael Marioli Antonio Orzelli	Paola Pilla Nicola Scantamburlo
Cirrus Logic Inc.	Sean Davis	Darren Holding	Brad Lambert
Corning Optical Communication LLC	Wojciech Giziewicz	Ian McKay	Jamie Silva
Cosemi Technologies Inc.	Samir Desai	Devang Parekh	
Cypress Semiconductor	Mark Fu Naman Jain Rushil Kadakia	Benjamin Kropf Venkat Mandagulathur Anup Nayak	Jagadeesan Raj Sanjay Sancheti Subu Sankaran
Dell	Mohammed Hijazi David Meyers Sean O'Neal	Ernesto Ramirez Siddhartha Reddy	Thomas Voor Merle Wood
Dialog Semiconductor (UK) Ltd.	Yimin Chen		
Diodes Incorporated	Kay Annamalai Justin Lee Paul Li	Bob Lo Jaya Shukla	Qun Song Ada Yip
DisplayLink (UK) Ltd.	Pete Burgers		
DJI Technology Co., Ltd.	Steve Huang		
Electronics Testing Center, Taiwan	Sophia Liu		
Elka International Ltd.	Roy Ting		
Ellisys	Abel Astley Rick Bogart	Mario Pasquali Chuck Trefts	Tim Wei
Etron Technology, Inc.	Chien-Cheng Kuo		
Feature Integration Technologies Inc.	Jacky Chan Chen Kris Yulin Lan	KungAn Lin Yuchi Tsao	Paul Yang Amanda Ying
Foxconn / Hon Hai	Patrick Casher Asroc Chen Joe Chen Allen Cheng Jason Chou Edmond Choy Fred Fons	Bob Hall Chien-Ping Kao Ji Li Ann Liu Terry Little Steve Sedio Christine Tran	Pei Tsao AJ Yang Yuan Zhang Jessica Zheng Jie Zheng Andy Yao
Foxlink/Cheng Uei Precision Industry Co., Ltd.	Robert Chen Sunny Chou Carrie Chuang Wen-Chuan Hsu Alex Hsue	Armando Lee Dennis Lee Justin Lin Robert Lu Tse Wu Ting	Steve Tsai Wen Yang Wiley Yang Junjie Yu
Fresco Logic Inc.	Bob McVay	Christopher Meyers	

Google	Alec Berg Joshua Boilard Alec Berg Todd Broch Jim Guerin Jeffrey Hayashida Mark Hayter	Nithya Jagannathan Lawrence Lam Adam Langley Ingrid Lin Richard Palatin Vincent Palatin Dylan Reid	Adam Rodriguez David Schneider Stephan Schooley Toshak Singhal Ken Wu
Granite River Labs	Yung Han Ang Sandy Chang Allen Chen Swee Guan Chua	Alan Chuang Mike Engbretson Caspar Lin	Krishna Murthy Johnson Tan Chin Hun Yaep
Hewlett Packard Inc. (USB Promoter company)	Lee Atkinson Srinath Balaraman Roger Benson Alan Berkema	Robin Castell Steve Chen Michael Krause Rahul Lakdawala	Jim Mann Linden McClure Mike Pescetto Asjad Shamim
Hirose Electric Co., Ltd.	Jeremy Buan William Kysiak Sang-Muk Lim	William MacKillop Gourgen Oganessyan	Eungsoo Shin Sid Tono
Hosiden Corporation	Takahisa Otsuji	Fumitake Tamaki	
I-PEX (Dai-ichi Seiko)	Alan Kinningham	Ro Richard	Tetsuya Tagawa
Infineon Technologies	Tue Fatt David Wee		
Intel Corporation (USB Promoter company)	Dave Ackelson Mike Bell Brad Berlin Pierre Bossart Kuan-Yu Chen Hengju Cheng Jhuda Dayan Paul Durley Saranya Gopal Howard Heck Hao-Han Hsu Seppo Ingalsuo Abdul (Rahman) Ismail James Jaussi	Ziv Kabiry Vijaykumar Kadgi Luke Johnson Jerzy Kolinski Rolf Kuhnis Henrik Leegaard Edmond Lau Xiang Li Yun Ling Guobin Liu Steve McGowan Sankaran Menon Chee Lim Nge Sagar Pawar	Sridharan Ranganathan Rajaram Regupathy Brad Saunders Ehud Shoor Amit Srivastava Einat Surijan Ron Swartz David Thompson Karthi Vadivelu Tsion Vidal Stephanie Wallick Rafal Wielicki Devon Worrell Li Yuan
Japan Aviation Electronics Industry Ltd. (JAE)	Kenji Hagiwara Hiroaki Ikeda Masaki Kimura Toshio Masumoto Kenta Minejima Toshiyuki Moritake Joe Motojima Ron Muir	Tadashi Okubo Kazuhiro Saito Kimiaki Saito Yuichi Saito Mark Saubert Toshio Shimoyama Tatsuya Shioda Atsuo Tago	Masaaki Takaku Jussi Takaneva Tomohiko Tamada Kentaro Toda Kouhei Ueda Takakazu Usami Masahide Watanabe Youhei Yokoyama
JPC/Main Super Inc.	Sam Tseng	Ray Yang	
LeCroy Corporation	Daniel H. Jacobs	Tyler Joe	
Lenovo	Rob Bowser Tomoki Harada	Jianye Li Wei Liu	Howard Locker

LG Electronics Inc.	Do Kyun Kim		
Lintes Technology Co., Ltd.	Tammy Huang	Max Lo	JinYi Tu
	Charles Kaun	CT Pien	Jason Yang
	RD Lintes		
Lotes Co., Ltd.	Ariel Delos Reyes	Charles Kaun	John Lynch
	Ernest Han	Chi-Chang Lin	JinYi Tu
	Mark Ho	Max Lo	Jason Yang
	Regina Liu-Hwang		
LSI Corporation	Dave Thompson		
Luxshare-ICT	Josue Castillo	Alan Kinningham	Sean O'Neal
	Daniel Chen	Gorden Lin	Scott Shuey
	Lisen Chen	John Lin	James Stevens
	Sally Chiu	Stone Lin	Pat Young
	CY Hsu	Alan Liu	
Maxim Integrated Products	Forrest Christo	Sang Kim	Michael Miskho
	Ken Helfrich	Jeff Lo	Jacob Scott
MCCI Corporation	Terry Moore		
MediaTek Inc.	Alex YC Lin		
MegaChips Corporation	Alan Kobayashi	Satoru Kumashiro	
Microchip (SMSC)	Josh Averyt	Matthew Kalibat	John Sisto
	Mark Bohm	Donald Perkins	Anthony Tarascio
	Shannon Cash	Richard Petrie	Kiet Tran
	Thomas Farkas	Mohammed Rahman	Christopher Twigg
	Fernando Gonzalez	Andrew Rogers	Prasanna Vengateshan
Microsoft Corporation (USB Promoter company)	Randy Aull	Teemu Helenius	Toby Nixon
	Jim Belesiu	Dan Jatco	Rahul Ramadas
	Michelle Bergeron	Kai Inha	Srivatsan Ravindran
	Fred Bhesania	Jayson Kastens	Nathan Sherman
	Anthony Chen	Andrea Keating	Bala Sivakumar
	Philip Froese	Shoaib Khan	Timo Toivola
	Vivek Gupta	Eric Lee	David Voth
	David Hargrove	Ivan McCracken	Andrew Yang
	Robbie Harris	Arvind Murching	Panu Ylihaavisto
	Robert Hollyer	Gene Obie	
Molex LLC	Adib Al Abaji	Alan MacDougall	
Monolithic Power Systems	Di Han	Chris Sporck	
MQP Electronics Ltd.	Sten Carlsen	Pat Crowe	
NEC Corporation	Kenji Oguma		
Newnex Technology Corp.	Sam Liu	Nimrod Peled	
Nokia Corporation	Daniel Gratiot	Samuli Makinen	Timo Toivola
	Pekka Leinonen	Pekka Talmola	Panu Ylihaavisto
NXP Semiconductors	Mahmoud EL Sabbagh	Ken Jaramillo	Guru Prasad
	Dennis Ha	Vijendra Kuroodi	Krishnan TN
Oculus VR LLC	Amish Babu	Marty Evans	Joaquin Fierro
ON Semiconductor	Eduardo De Reza	Christian Klein	Michael Smith
	Oscar Freitas	Amir Lahooti	

Parade Technologies, Inc.	Jian Chen Craig Wiley	Paul Xu	Alan Yuen
Power Integrations	Shruti Anand Rahul Joshi	Aditya Kulkarni Akshay Nayaknur	Amruta Patra
Qualcomm, Inc.	Lior Amarilio Aris Balatsos Tomer Ben Chen Richard Burrows Amit Gil James Goel Amit Gupta	Philip Hardy Will Kun Jonathan Luty Lalan Mishra George Paparrizos Vatsal Patel	Jack Pham Vamsi Samavedam Matthew Sienko Dmitrii Vasilchenko Joshua Warner Chris Wiesner
Realtek Semiconductor Corp.	Marco Chiu Tsung-Peng Chuang Charlie Hsu Fan-Hau Hsu	Ty Kingsmore Ray Lee Jay Lin Ryan Lin	Terry Lin Chuting Su Changhung Wu
Renesas Electronics Corp. (USB Promoter company)	Kai Bao Bob Dunstan Nobuo Furuya	Philip Leung Kiichi Muto Ziba Nami	Hajime Nozaki Yosuke Sasaki Toshifumi Yamaoka
Richtek Technology Corp.	Roger Lo		
Rohm Co., Ltd.	Mark Aaldering Kris Bahar Ruben Balbuena Nobutaka Itakura	Yusuke Kondo Arun Kumar Chris Lin Kazuomi Nagai	Yoshinori Ohwaki Takashi Sato Hiroshi Yoshimura
Samsung Electronics Co., Ltd.	Jaedeok Cha KangSeok Cho WooIn Choi Yeongbok Choi Cheolyoon Chung JaeRyong Han Jaehyeok Jang Wonseok Jang	Sangju Kim Soondo Kim Woonki Kim Jagoun Koo Termi Kwon Cheolho Lee Edward Lee	Jun Bum Lee Jinyoung Oh Chahoon Park Chulwoo Park Youngjin Park Jung Waneui Sunggeun Yoon
Seagate	Alvin Cox Emmanuel Lemay	Tony Priborsky Tom Skaar	Dan Smith
Shenzhen Deren Electronic Co., Ltd.	Smark (Zhudong) Huo Wen Fa Lei	Yang Lirong	Lucy Zhang
Silicon Line Gmbh	Ian Jackson		
SiliConch Systems Private Limited	Jaswanth Ammineni Pavitra Balasubramanian Kaustubh Kumar Aniket Mathad	Shubham Paliwal Jinisha Patel Vinay Patel Rakesh Polasa	Vishnu Pusuluri Abhishek Sardeshpande Satish Anand Verkila
Simula Technology Inc.	John Chang Voss Cheng Thomas Li	Jung Lin Jyunming Lin Doris Liu	CK Wang Alice Yu
Softnautics LLP	Bhavesh Desai Hetal Jariwala	Dipakkumar Modi Ishita Shah	Ujjwal Talati
Sony Corporation	Shinichi Hirata	Shigenori Tagami	
Spectra7 Microsystems Corp.	Andrew Kim	James McGrath	John Mitchell
Specwerkz	Amanda Hosler	Diane Lenox	

STMicroelectronics (USB Promoter company)	Jerome Bach Nathalie Ballot Filippo Bonaccorso Christophe Cochard Nicolas Florenchie Cedric Force	Gregory Cosciniak Chekib Hammami Joel Huloux Christophe Lorin Patrizia Milazzo Federico Musarra	Pascal Legrand Richard O'Connor Massimo Panzica Legrand Pascal Nicolas Perrin
Sumitomo Electric Ind., Ltd.	Takeshi Inoue Yasuhiro Maeda	Wataru Sakurai Sainer Siagian	Masaki Suzuki Mitsuaki Tamura
Synaptics Inc.	Daniel Bogard	Jeff Lukanc	Prashant Shamarao
Synopsys, Inc.	Subramaniam Aravindhan	Morten Christiansen Nivin George	Satya Patnala
Tektronix, Inc.	Randy White		
Texas Instruments (USB Promoter company)	Jawaid Ahmad Mike Campbell Greg Collins Gary Cooper GP Gopalakrishnan Craig Greenberg Richard Hubbard Nate Johnson Michael Koltun IV Yoon Lee Grant Ley	Win Maung Shafiuddin Mohammed Lauren Moore Brian Parten Martin Patoka Jason Peck John Perry Louis Peryea Brian Quach	Sai Karthik Rajaraman Wes Ray Dafydd Roche Anwar Sadat Cory Stewart Sue Vining Bill Waters Deric Waters Gregory Watkins Roy Wojciechowski
Total Phase	Chris Yokum		
Tyco Electronics Corp. (TE Connectivity Ltd.)	Max Chao Robert E. Cid Calvin Feng Kengo Ijiro Eiji Ikematsu Joan Leu Clark Li	Mike Lockyer Jeff Mason Takeshi Nakashima Luis A. Navarro Masako Saito Yoshiaki Sakuma Gavin Shih	Hiroshi Shirai Hidenori Taguchi Nathan Tracy Bernard Vetten Ryan Yu Noah Zhang Sjoerd Zwartkruis
UL LLC	Michael Hu		
Varjo Technologies	Kai Inha		
Ventev Mobile	Brad Cox	Colin Vose	
VIA Technologies Inc.	Terrance Shih	Jay Tseng	Fong-Jim Wang
Weltrend Semiconductor	Hung Chiang Jeng Cheng	Wayne Lo Ho Wen Tsai	Eric Wu
Xiaomi Communications Co., Ltd.	Xiaoxing Yang	Juejia Zhou	

### Pre-Release Draft Industry Reviewing Companies That Provided Feedback

Aces	JST Mfg. Co., Ltd.	Pericom
Fairchild Semiconductor	Korea Electric Terminal	Semtech Corporation
Fujitsu Ltd.	Marvell Semiconductor	Silicon Image
Industrial Technology Research Institute (ITRI)	Motorola Mobility LLC PalCONN/PalNova (Palpilot International Corp.)	SMK Corporation Toshiba Corporation

Joinsoon Electronics Mfg. Co.  
Ltd.

### Revision History

Revision	Date	Description
1.0	August 11, 2014	Initial Release
1.1	April 3, 2015	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.
1.2	March 25, 2016	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.
1.3	July 14, 2017	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.
1.4	March 29, 2019	Reprint release including incorporation of all approved ECNs as of the revision date plus editorial clean-up.
2.0	August 2019	New release primarily for enabling USB4 over USB Type-C connectors and cables. Also includes incorporation of all approved ECNs as of the revision date plus editorial clean-up.

## 1 Introduction

With the continued success of the USB interface, there exists a need to adapt USB technology to serve newer computing platforms and devices as they trend toward smaller, thinner and lighter form-factors. Many of these newer platforms and devices are reaching a point where existing USB receptacles and plugs are inhibiting innovation, especially given the relatively large size and internal volume constraints of the Standard-A and Standard-B versions of USB connectors. Additionally, as platform usage models have evolved, usability and robustness requirements have advanced and the existing set of USB connectors were not originally designed for some of these newer requirements. This specification is to establish a new USB connector ecosystem that addresses the evolving needs of platforms and devices while retaining all of the functional benefits of USB that form the basis for this most popular of computing device interconnects.

### 1.1 Purpose

This specification defines the USB Type-C® receptacles, plug and cables.

The USB Type-C Cable and Connector Specification is guided by the following principles:

- Enable new and exciting host and device form-factors where size, industrial design and style are important parameters
- Work seamlessly with existing USB host and device silicon solutions
- Enhance ease of use for connecting USB devices with a focus on minimizing user confusion for plug and cable orientation

The USB Type-C Cable and Connector Specification defines a new receptacle, plug, cable and detection mechanisms that are compatible with existing USB interface electrical and functional specifications. This specification covers the following aspects that are needed to produce and use this new USB cable/connector solution in newer platforms and devices, and that interoperate with existing platforms and devices:

- USB Type-C receptacles, including electro-mechanical definition and performance requirements
- USB Type-C plugs and cable assemblies, including electro-mechanical definition and performance requirements
- USB Type-C to legacy cable assemblies and adapters
- USB Type-C-based device detection and interface configuration, including support for legacy connections
- USB Power Delivery optimized for the USB Type-C connector

The USB Type-C Cable and Connector Specification defines a standardized mechanism that supports [Alternate Modes](#), such as repurposing the connector for docking-specific applications.

### 1.2 Scope

This specification is intended as a supplement to the existing [USB 2.0](#), [USB 3.2](#), [USB4™](#) and [USB Power Delivery](#) specifications. It addresses only the elements required to implement and support the USB Type-C receptacles, plugs and cables.

Normative information is provided to allow interoperability of components designed to this specification. Informative information, when provided, may illustrate possible design implementations.

August 2019

### 1.3 Related Documents

- USB 2.0** *Universal Serial Bus Revision 2.0 Specification*  
This includes the entire document release package.
- USB 3.2** *Universal Serial Bus Revision 3.2 Specification*  
This includes the entire document release package.  
*USB 3.1 Legacy Cable and Connector Specification, Revision 1.0*
- USB4** *USB4™ Specification, Version 1.0, August 2019*  
(including posted errata and ECNs)
- TBT3** Chapter 13 of *USB4 Specification, Version 1.0, August 2019*
- USB PD** *USB Power Delivery Specification, Revision 2.0, Version 1.3, January 12, 2017*  
*USB Power Delivery Specification, Revision 3.0, Version 2.0, August 2019*  
(including posted errata and ECNs)
- USB BB** *USB Billboard Device Class Specification, Revision 1.21, September 8, 2016*
- USB BC** *Battery Charging Specification, Revision 1.2 (including errata and ECNs through March 15, 2012), March 15, 2012*
- DP AM** *DisplayPort™ Alt Mode on USB Type-C Standard, Version 1.0b, 03 November 2017*

All USB-specific documents are available for download at <http://www.usb.org/documents>. The DisplayPort Alt Mode specification is available from VESA (<http://www.vesa.org>).

### 1.4 Conventions

#### 1.4.1 Precedence

If there is a conflict between text, figures, and tables, the precedence shall be tables, figures, and then text.

#### 1.4.2 Keywords

The following keywords differentiate between the levels of requirements and options.

##### 1.4.2.1 Informative

Informative is a keyword that describes information with this specification that intends to discuss and clarify requirements and features as opposed to mandating them.

##### 1.4.2.2 May

May is a keyword that indicates a choice with no implied preference.

##### 1.4.2.3 N/A

N/A is a keyword that indicates that a field or value is not applicable and has no defined value and shall not be checked or used by the recipient.

##### 1.4.2.4 Normative

Normative is a keyword that describes features that are mandated by this specification.

##### 1.4.2.5 Optional

Optional is a keyword that describes features not mandated by this specification. However, if an optional feature is implemented, the feature shall be implemented as defined by this specification (optional normative).